INDUSTRY BRIEF – MOBILITY

Since three-hundred thousand years, when humans moved within Africa and out of Africa to virtually every square kilometer of the earth's land mass,[1] h umans have shared informal and more formal means of transportation. mobility has been central to an overarching theme of human history: greater integration, specialization, and complexity.

In addition, for most of our history, the transfer of information and ideas required the ability of humans to move and connect. Since the invention of the telegraph less than 200 years ago, ideas and knowhow move independently of humans. Nevertheless, our aggregate demand for movement is huge. The dramatic increase in our collective movements – we lack a reliable measure – is due to the precipitous decrease in cost of travel in terms of money, time, and effort. As much as we complain about traffic and delays, modern humans have an abundance of options to get from Mumbai to Los Angeles, or from lower Manhattan to Yankee Stadium. These options bear little resemblance to the arduous and dangerous options from centuries ago.

1. INTRODUCTION

Societies have developed a variety of methods and institutions for the transportation of goods and people. Some methods are informal, like hitchhiking (which was common when your professor was in his teens and twenties), and carpooling. Others, like common carrier arrangements,[2] have been important complements to investments in ferries, trains, buses, and planes.[2]

New technologies like ridesharing, autonomous vehicles, and advanced air transportation are shaping a radically different future of mobility. Age-old questions, however, remain about (i) the mix of public and private transportation, (ii) the roles of government, and (iii) the profitability of industry participants.

In Section 2, we identify the economic factors that continue to influence how various industries are evolving. In Section 3 we go into detail about *ridesharing*. In Section 4, we focus on *micromobility*: e-bikes and e-scooters for short-distance travel. In Section 5, we turn to Electronic Vehicles (EVs) and emerging ecosystems. In Section 6, we identify some other emerging technologies. In Section 7, we consider the role of governments. In Section 8 we offer some comments about profitability.

2. ECONOMICS O20F MOBILITY

A licensed black London taxi can take up to five passengers and luggage from Mayfair to Heathrow Airport. Whether the cabbie would get a quick fare back to the City depends on the density of passengers and their geographic distribution. This example illustrates the importance of economies of scale (low marginal costs up to capacity) and network effects (density of passengers at nodes).

[1] Schlebusch; et al. (3 November 2017). "Southern African ancient genomes estimate modern human divergence to 350,000 to 260,000 years ago". Science. 358 (6363): 652–655.
[2] https://www.investopedia.com/terms/c/common-carrier.asp

Another economic factor is economies of scope. Once an airport becomes a hub, the costs of adding additional city-pair flights is low compared to the cost of doing so without the hub. In addition, once Delta offers a flight from Atlanta to Los Angeles, it may find it more attractive to offer flights from Los Angeles to Jakarta.

Yet another factor in transportation industries is the important role of specific assets, which we observe wherever we go. Railroads have tracks and stations. When we get off the train, we very well may get on a subway to the airport. Assets like gates at airports are location-specific and sometimes specific to types of aircraft.

These economic factors (economies of scope, economies of scale, network effects, and specific assets) are relevant, even for cutting-edge transportation. How different is the London cab that holds five tourists from a SpaceX capsule that holds 5 space travelers? And once space stations support travel to Mars, they may also support travel beyond the solar system.

Regarding competition, we should bear in mind that different modes of transportation sometimes are substitutes for each other, e.g., taxis and ridesharing, while in other settings, they can be complements, e.g., subways and bike sharing.

3. RIDESHARING

Ridesharing platforms have generated vast amounts of consumer surplus, especially for people who lacked access to traditional taxis and public transportation. Along with the importance of relatively technological innovations, the success of ridesharing illustrates the importance of network effects and economies of scope.

By allowing owners of vehicles to join platforms like Uber, Didi, and Lyft, ridesharing has expanded dramatically the supply of short-distance transportation services for individuals and, as a result, greatly expanded access to transportation for many people. Radio dispatch services still exist and sight-based street hailing works in some urban areas, but customers around the world now use their smart phones to order a ride. Passengers have a record of identity of the driver and the vehicle. They also can pay using linked payment systems.

Ridesharing services, of course, gain personal information about riders. How valuable is that information? For insights see brief on *Collection and Monetization of Personal Information*. Of note, successful ridesharing platforms have entered adjacent lines of business, e.g., food delivery and providing e-scooters.

Ten Initial Observations

1. Platforms operate two-sided markets with drivers and customers.
2. The technological barriers to entry appear are low. But getting sufficient numbers of drivers and customers is far from automatic.
3. Drivers can choose to affiliate with a platform and typically decide when and how much labor to supply.[3]

[3] In most cities with data available, UberX drivers spend a significantly higher fraction of their time, and drive a substantially higher share of miles, with a passenger in their car than do taxi drivers. (Rf. Cramer Krueger 2016).

4. Drivers sometimes affiliate with more than one platform and also can switch over time from one to another.
5. Customers can easily download ridesharing apps to access drivers. This by itself suggests that switching costs are low.[4]
6. Customers pay fares to the platform and the platform shares some portion of revenues with drivers.
7. Despite relevant economies of scale and network economies, rivalry among current providers is intense in many localities. If the local market is "big enough" – an imprecise term – rivals offer virtually indistinguishable ridesharing services, e.g., Uber and Lyft in the US; MyTaxi and a large number of firms in Europe.
8. Rivalry continues despite consolidation and exit. (Uber sold its business in Russia to the local market leader Yandex.Taxi. Uber sold out its business in Singapore to Grab).
9. Aggregate consumer surplus has sky-rocketed due to lower prices, dramatic increases in ride volume, and the greatly expanded scope of services.[5]
10. Regulation varies greatly across cities, states, countries, and regions. In some cases, regulatory restrictions have forced ridesharing companies to exit markets that could otherwise have been profitable.[6]

How Ridesharing Works

Customers set up the account through their phone, confirms their phone number, types in their e-mail address, basic contact information, and credit card details. A customer specifies the destination and then the ridesharing app matches drivers and riders to pick up the passenger and drop off the passenger at the pre-defined destination. The apps use GPS sensors to determine the current location; the customer only needs to choose the destination and the type of service (standard, premium, luxury, and others). Once the customer makes a pick-up request, the fare is specified, and the customer decides whether to proceed with the transaction.

The selected driver is notified via mobile app and is provided the customer's location. The driver has very limited time to accept the request. Whether the driver knows the destination appears to vary across platforms. Information on the driver is immediately displayed to the customer. Once the ride is completed, both parties can leave a review; the rider can also add a tip.

Drivers can log into the app whenever they want, and there are no minimum-hour requirements. Drivers can own or rent their vehicle; most apps have certain standards for vehicles, but they vary country by country. Drivers get paid directly into their bank account, usually on a weekly basis.

Transactions

Commissions from rides are the primary revenue source for ridesharing businesses. Fares are transparent to customers, but the effective price can be affected by discounts and credits for

[4] Other factors discourage switching. For example, after learning where your Uber driver can pick you up at a sprawling airport may discourage riders from switching to a different ridesharing company.

[5] Ridesharing helps adjusting the balance of supply and demand: the number of Uber (Lyft) rides is about 22 percent higher when it is raining, while number of taxi rides is about 5 percent higher when it is raining. (Brodeur Nield 2018).

[6] As an example, Uber has been refused a license to operate in London first in 2017, and then again in 2019. It was only in 2020 that the court ruled in favor of Uber (see https://www.cnbc.com/2020/09/28/uber-granted-temporary-london-license.html). That license was extended in 2022 for 30 months, see https://www.cnbc.com/2022/03/26/uber-wins-30-month-london-license.html.

frequent use. In some contexts, platforms subsidize the drivers to gain density and provide for efficient service to potential customers. Given these factors, what a customer pays for a given ride is not always clear. In addition, how fares paid by riders are shared between the platform and driver is not transparent.[7]

Fares are subject to surge pricing when high demand is high. The record-high surge price is reported to be 5,000 percent.[8] Surge pricing was sometimes met with disapproval from drivers and the public; in response, some ridesharing companies introduced surge pricing caps. Surge pricing creates incentives for drivers to increase supply and for customers to consider alternatives.[9]

Data on driver earnings are noisy. Berger et al. (2018) estimated that the median London driver earns about £11 per hour spent logged into the app. Anecdotal sources report much lower earnings. Measurement of driver earnings is complicated. How platforms divide the total price paid by passengers varies. In addition, drivers with more rides and higher rankings receive more requests. Lastly, drivers may receive compensation by affiliating with multiple ridesharing apps.[10]

Some platforms offer pooling, i.e., matching riders going into the same direction and minimizing their ride time using sophisticated algorithms. Uber and Lyft have offered pooling in most metropolitan areas in the US. Uber also operates an express pool option in selected locations, where riders may have to walk to their pick-up location/drop-off point up to 3 minutes in exchange for 20-40 percent discount. Didi offers a similar option is many major cities in China.

The future is bright, in part because of demographics. Ridesharing is particularly appealing to younger generation: 51 percent of people aged 18 to 29 declared using a ridesharing service compared with 24 percent of those ages 50 and older, based on data from Pew Research Center.[11] Another factor is that autonomous vehicles will make the ridesharing industry yet more efficient. All many rivals are investing billions into research that would eventually yield a reliable driverless car and replace human drivers, the single most expensive input in the business. To date, however, no manufacturer seems to have achieved level 5 autonomy, meaning the car could operate completely driverless anywhere, under any circumstances, which would be required for self-driving taxis. Of note, Elon Musk has heavily promoted robotaxis, i.e., self-driving Tesla cars that turn into a taxi when owners do not need them. Tesla, however, did not meet Musk's goal of "1 million Tesla robotaxis by 2020."

4. MICROMOBILITY

This is a hot topic in transportation. Even though the beginnings of micromobility reach back to the invention of a bicycle in the 19th century, emergence of technologies focused attention on small, lightweight, user-operated vehicles, whose speed does not exceed 15mph. These include traditional bicycles, e-bikes, electric scooters and skateboards, and the like. When in late 2010s startups such

[7] It appears that Uber originally took 20 percent of fares, but has tried raising its "take percentage" to 25 percent and 30 percent. Lyft and Grab appear to charge about 25 percent. Platforms have probably experimented with more complex pricing schemes based on multiple factors (distance driven, time spent, miscellaneous fees).

[8] https://www.businessinsider.com/ubers-highest-surge-price-ever-may-be-50x-2014-11

[9] Some drivers are reported to have colluded to artificially create surge prices. https://www.inc.com/minda-zetlin/uber-lyft-drivers-artificial-surge-pricing-reagan-national-washington-arlington-drive-united.html

[10] https://www.mckinsey.com/industries/automotive-and-assembly/our-insights/five-covid-19-aftershocks-reshaping-mobilitys-future

[11] https://www.pewresearch.org/fact-tank/2019/01/04/more-americans-are-using-ride-hailing-apps/

as Lime, Bird or Neuron Mobility started offering scooter-sharing services in big cities, micromobility devices increased in popularity, and the companies offering them saw their valuations skyrocket[12].

Micromobility platforms offer devices dispersed through urban areas. A stray scooter can be activated and paid for via a dedicated app, with charges ranging from $0.15 to about $1 per minute of rental. The scooters are dockless, which means that they can be picked up and dropped off almost anywhere in the city.

The main difference between ridesharing and micromobility platforms is that the latter do not operate in a two-sided market setting. Instead, they do own a fleet of electric scooters and e-bikes, which has major implication on their balance sheets and P&L statements, as well as the way they operate their businesses (e.g., the need to service and maintain the devices).

5. THE SHIFT TO ELECTRIC VEHICLES (EVs) AND EMERGING ECOSYSTEMS

Almost two centuries ago, people experimented with EVs.[13] The commercial shift to EVs only began in the early 2000s when Tesla entered the market. Recent years have seen exponential growth in the sale of EVs. In 2011, the global share of EVs within passenger car sales was a meager 0.07 percent, but by 2022 it soared to 14 percent.[14] As of 2022, the number of EVs in operation worldwide exceed 16.5 million.[15] Bloomberg NEF estimates that by 2025 EVs will account for nearly a quarter of sales (closer to 40 percent in Europe and China), and that by 2040 around 75 percent of new car sales will be EVs.[16]

Emissions regulations, worsening air quality, and government subsidies have contributed to the shift to EVs. The EU's proposal to ban the sale of internal-combustion engine vehicles (ICEs) by 2035 is perhaps the most drastic.[17] The US offering generous tax credits for new EVs,[18] and subsidizes EV charging infrastructure.[19]

EV manufacturers face three strategic issues: (i) whether to vertically integrate backward and to what extent, (ii) how to distribute their vehicles, and (iii) the geographic scope of their operations.. Tesla has manufacturing capabilities in US, Germany, and China.

EV manufacturers also face the question of whether to build out their own charging infrastructure. In the West, Tesla's infrastructure is by far the largest, with 19,700 charging ports across the USat about 1,800 stations. Ford and GM recently decided to rely on Tesla's charging infrastructure in the US.[20] This appears to be a step in the development of a Tesla-centric ecosystem.

The shift to EVs has been most pronounced in Northern Europe and China, the largest EV manufacturer in the world. Sales in developing and emerging countries have been slow due to

[12] https://www.cnbc.com/2018/07/11/lime-bird-spin-why-scooter-start-ups-are-suddenly-worth-billions.html
[13] https://www.economist.com/special-report/2023/04/14/an-electric-shock.
[14] https://www.statista.com/statistics/1371599/global-ev-market-share/
[15] https://www.iea.org/reports/electric-vehicles.
[16] https://www.economist.com/special-report/2023/04/14/an-electric-shock.
[17] Whether the ban enters into effect is yet to be seen, as some EU countries such as Germany and Poland are pushing back, see e.g. https://europe.autonews.com/environmentemissions/poland-appeal-2035-combustion-car-ban-eu-court. The EU is legally obligated to become carbon-neutral by 2050.
[18] https://fueleconomy.gov/feg/taxcenter.shtml.
[19] https://www.transportation.gov/rural/ev/toolkit/ev-infrastructure-funding-and-financing/federal-funding-programs.
[20] https://www.bloomberg.com/news/features/2023-06-11/tesla-dominant-in-us-charging-invites-ford-gm-evs-to-fuel-up, https://www.nytimes.com/2023/06/27/business/energy-environment/tesla-gm-ford-charging-electric-vehicles.html.

higher purchase costs and a lack of charging infrastructure availability. The International Energy Agency estimates that in the short term, the greatest obstacles to continued strong EV sales are soaring prices for some critical minerals essential for battery manufacturing[21]. EV manufacturers, notably Tesla, have fiercely competed for access to such minerals.

Sales in 2021 were the highest in China at 3.3 million (tripling 2020 sales), followed by Europe with 2.3 million and the United States at 630,000. The largest EV manufacturers include China's BYD, Tesla, VW and General Motors. [22] Others include Li Auto and Rivian; there are many new entrants as well. [23]

Importantly, the shift to EVs is contributing to the development of new ecosystems involving these vehicles, the infrastructure required for charging, the Internet of Things (IoT), and the development of autonomous vehicles. According to McKinsey, innovations in the space of personal mobility can be referred to as ACES: autonomous driving, connected cars, electrified vehicles, and shared mobility.[10] The pace of development in each of these areas might end up dictating what the market will look like in a few years. Who will end up leading the race to control the market and make the highest profits? It seems that the ridesharing industry is best positioned to do so, but it might well be the case that a market leader will emerge from a different industry. It might well be the case that a company like SpaceX, with its plans to move people around the world in 30 minutes in its space rockets,[24] or an e-commerce giant like Amazon, with its Prime drones,[25]will dominate the market.

6. EMERGING TECHNOLOGIES

Advanced Air Mobility (AAM)

AAM refers to technology allowing to transport passengers and goods in a cost-effective and community-friendly way, utilizing electric vertical takeoff and landing (eVTOL) aircrafts. As of 2021, over 200 automotive, aerospace and tech companies and startups around the world are working to develop the aircrafts and adjacent solutions, such as sensors and energy storage units. It is forecasted that AAM will become a mainstay in mobility by 2030, with the market worth USD 115 billion by 2035.[26]

The main promise of the eVTOL aircrafts lies in their ability to take off and land in different surroundings, as they do not need a runway. As such, they are poised to replace helicopters, ground vehicles and airplanes in urban and rural settings. Their design, usually high automation and energy efficiency translate into a reduction in production, operating and maintenance costs. As their flight range increases and navigation technology improves, they stand to usher a new era of air mobility.

Questions abound. Will aircraft be privately owned or shared[27]? Will they be offered on platforms more similar to those of Uber and Grab, or those of Lime and Bird? What sorts of partnerships will enable these new business models?

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[21] https://www.iea.org/reports/global-supply-chains-of-ev-batteries.

[22] https://www.engadget.com/gm-is-now-the-second-largest-ev-maker-in-the-us-181556063.html. "Chinese manufacturer BYD sells 20 percent of the world's EVs, to Tesla's 12.6 percent."

[23] https://www.businessinsider.com/ev-electric-vehicle-china-brands-byd-nio-wuling-zeekr-geely-2023-5#5-xpeng-has-ambitions-to-deliver-half-of-the-vehicles-it-produces-to-countries-outside-china-6.

[24] https://www.ted.com/talks/gwynne_shotwell_spacex_s_plan_to_fly_you_across_the_globe_in_30_minutes

[25] https://www.amazon.com/Amazon-Prime-Air/b?ie=UTF8&node=8037720011

[26] https://www2.deloitte.com/us/en/insights/industry/aerospace-defense/advanced-air-mobility.html

[27] Global pandemic caused a surge in popularity of shared private jets, with customer numbers increasing even threefold. As of June 19, 2023, none of the jet-sharing companies is publicly listed.

Other Innovations

In 2016, Brazilian startup Flapper began matching passengers with seats on private aircraft, while Uber launched, temporarily or permanently, UberBOAT and UberHELI (UberCopter[28]) services in Croatia, Mumbai, New York City, and Dubai, among others. Uber also tried to launch UberHealth and UberRush; currently it is expanding UberFreight, which provides Uber-style freight transportation in US.

Gojek offers identical services in Indonesia, in addition to golaudry (mobile laundry services), gosend (delivering packages), gomed (delivering medication from pharmacies in the Jakarta and Surabaya areas), and 10+ other services.

ZipCar is the largest American **car-sharing** company. Founded in 2000, Zipcar provides short-term (min. 30 minutes) automobiles to its members and operates a fleet of 12,000 vehicles. The company was purchased in 2013 for ~$500 million by Avis Budget Group, the leading general-use vehicle rental company in North America.

Turo, a San Francisco, CA-based private company that facilitates car-sharing among peers. Private car owners rent out their vehicles via an online and mobile interface. In 2017, according to Turo, four million users had registered to use the service and 170,000 privately owned cars were available for rental in 2100+ across the US. As of September 2019, Turo received over $430 million in venture funding.

BlaBlaCar is a French online marketplace for **carpooling**. BlaBlaCar had 70 million users in 2019 and is available in 22 countries, mostly in Europe. BlaBlaCar receives a 12 percent commission from every booking. A $200 million series D funding round in 2015 gave the company a $1.6 billion valuation, but following rounds lowered it to around 1.2 billion[29].

China-based Mobike and Ofo operate **station-less bicycle** sharing schemes in China, Singapore, and some European countries. Ofo at this peak was valued at up to $2 billion, had over 62.7 million monthly active users using over 10 million bicycles in 250 cities and 20 countries. However, the company had since dissolved its international division, had its Singapore operating license suspended, and struggled to remain solvent. Mobike was acquired by Chinese web company Meituan-Dianping for US$2.7 billion in 2018; most recently it experimented with electric bicycles.

New **lithium-metal batteries** are likely to change what types of vehicles societies use. VW invested in a Silicon Valley startup QuantumScape that claims it is on the verge of a breakthrough in how to use lithium, the lightest metal on the periodic table.[30] Lithium-ion batteries, currently used to power EVs are too costly, heavy, and do not charge well enough. Hence, only 2 percent of new car sales in the US currently are EV.

New generation of GPS will bring massive improvements to location and navigation accuracy. Since GPS first started in 1993, its users have been able to locate their positions in any place on

[28] Uber Copter, Uber's helicopter shuttle service, is available on Uber's app in a model different than "traditional" rides, where the platform is an intermediary between drivers and riders (i.e. it is not a two-sided market). To deliver the helicopter service, Uber partnered with licensed direct air carriers, whose service it is selling to customers through the platform.

[29] https://www.bloomberg.com/news/articles/2018-08-15/investor-cuts-valuation-of-europe-s-1-billion-dollar-startups.

[30] Rf. MIT Technology Review, "Lithium-Metal Batteries", pp. 38-41, Volume 124, Number 2, Mar/Apr 2021 https://www.technologyreview.com/2021/02/24/1018102/lithium-metal-batteries-electric-vehicle-car/

Earth based on signal from 24 or more GPS satellites orbiting the earth.[31] While current accuracy is within 5 to 10 meters, new GPS technologies will be able to identify positions down to a centimeter or a millimeter. The technology is highly complementary to micromobility industry. One of the leaders of the race is China with its BeiDou satellite constellation, though it is facing worldwide competition: Colorado-based Maxar is investing in six new Satellites known as "Worldview Legion," whose precision will be around 1.1 foot (1/3 meter)[32]. Of course, various militaries around the world are investing as well.

7. THE ROLE OF THE GOVERNMENT

As soon as governments gained to means of regulating transportation, they have done so. Toll roads have existed since ancient times, when countries controlling popular trade routes charged fees to travelers who wanted to use certain stretches of the road. Railroads in the US were first regulated in 1887, mostly in response to railway companies' monopolistic practices. The Interstate Commerce Act of 1887 also laid the foundation to common carrier laws.[33]

With innovations in mobility, several new "gray zones" have led to government interventions and wide-ranging litigation. Indeed, from employee rights of drivers working for ridesharing companies, through licenses to operate e-scooters fleets in cities, to safety requirements for AAM aircrafts, regulatory bodies across the world are struggling to keep up and devise comprehensive legislations.

Most countries had little to no regulation regarding ridesharing, which some businesses (in particular Uber) exploited. Nonetheless the regulatory climate surrounding the industry is uncertain: Uber was previously banned from operating in London, San Francisco, Brazil, Berlin, and dozens of other cities. In some settings, Uber has negotiated a milder regulation that would enable it to continue operating; the company has openly disregarded orders from regulators in some areas, and it voluntarily pulled out of other areas. Still, no jurisdiction seems to have comprehensive regulations regarding ridesharing. Uber and others continue to claim that their drivers are independent contractors, not employees; municipalities and central governments continue to challenge that view.[34]

Ridesharing has provoked backlashes from taxi drivers and their unions. NYC has adopted complex regulations to protect them. The State of California in August 2020 declared that ride-sharing companies could no longer claim that drivers are independent contractors.

Ridesharing businesses widely use background checks before allowing drivers to work for them, yet such checks are often deemed more lenient than at traditional taxi corporations. On the other hand, information about each ride is collected, which deters criminal activity by drivers.

As we look into the future, there are many more challenges ahead. Probably the most important ones pertain to ethics. As autonomous vehicles software is developed, what sort of ethical principles should be applied? In an accident, should a self-driving car be programmed to try to save lives of the most people, or of the owner? Or maybe of the most vulnerable people involved in a crash, e.g. children? Should a buyer have a choice when it comes to the set ethical principles

[31] Rf. "Hyper-accurate Positioning", pp. 44-45. Volume 124, Number 2, Mar/Apr https://www.technologyreview.com/2021/02/24/1017805/hyper-accurate-global-positioning-available-worldwide/
[32] WSJ, "Earth to Techies: Let's Map it All", Page A15, March 1, 2021
[33] https://medium.com/@TebbaVonMathenstien/network-neutrality-a-history-of-common-carrier-laws-1884-2018-2b592f22ed2e
[34] Rf. www.investopedia.com/articles/4-challenges-uber-will-face-next-years.

the car is equipped with? Currently, we rarely consider alternative outcomes, oftentimes saying that "an accident is an accident." When we will be able to (and will have to) make such decisions in advance, we will have to confront some very difficult choices.

8. PROFITABILITY

One might believe that economies of scale, network effects, economies of scope would have contributed to above normal-profits for industry leaders. But it is important to ask, leaders in what parts of the "value chain"? For example, EVs will constitute a big market, but how will the supply-side surplus be divided among (i) EV manufacturers, (ii) suppliers of batteries, and (iii) those who control the infrastructure.

What do we see in ridesharing? Uber has posted huge annual losses since its incorporation. In 2022, Uber posted a net loss of $9.14 billion. Dara Khosrowshahi, the former CEO of Uber, previously justified enormous expenses and continuing losses with a realization that "Uber is well positioned to penetrate a $12 trillion addressable market."

The market capitalization of Uber (NYSE:UBER) as of June 2023 was $88 billion, only slightly above its IPO valuation of $80 billion in May 2019 of. Lyft is similarly not profitable, and its stock has lost almost 90% of its value since the IPO on NASDAQ in March 2019. Despite the lack of profitability, ridesharing has been enormously popular among investors and venture capitalists. For example, Uber has received a total of $6.61 billion in financing through 12 rounds of financing between 2009 and 2015; Grab is reported to have received at least $7.5 billion, [35] while Gojek received $1.2 billion in series F alone.

MAJOR RIDESHARING FIRMS

Areas of operation	Company	Founded in	Valuation
Worldwide (USA)	Uber	2009	$88 billion (19/6/2023)
US	Lyft	2012	$3.88 billion (19/6/2023)
Indonesia	Gojek	2010	~$26.6 billion[36]
Singapore, Southeast Asia	Grab	2012	$13.29 billion[37]
Russia, other CIS countries	Yandex.Taxi	2011	unclear[38]
China, others	Didi Chuxing	2012	$14.3 billion[39]
Estonia, Poland, others	Bolt (Taxify)	2013	€6.8 billion[40]
India, others	OlaCab	2010	$4.8 billion[41]
Russia, Israel, UK	Gett	2010	$258 million[42]
US, UK, ~20 others	Via	2012	$750 million (Sept 2017)
Germany, Europe	FreeNow (myTaxi)	2011	Unknown

[35] https://news.crunchbase.com/news/grab-confirms-1-46b-softbank-investment/
[36] https://finance.yahoo.com/quote/GOTO.JK/key-statistics/, as of June 19, 2023.
[37] https://companiesmarketcap.com/grab/marketcap/, as of June 19, 2023.
[38] Yandex.Taxi is member of Yandex, a holding company, which as of June 19, 2023 is valued at $6.8 billion.
[39] https://finance.yahoo.com/quote/DIDIY/, as of June 19, 2023.
[40] Pre-money valuation under the most recent (series F) financing, see https://www.crunchbase.com/funding_round/mtakso-series-f--eed32432.
[41] https://techcrunch.com/2023/05/10/vanguard-trims-indian-ride-hailing-giant-ola-valuation-by-35/.
[42] https://www.calcalistech.com/ctechnews/article/hk6z1mjjs.

South Korea, Japan	KakaoTaxi	2015	Unknown
Iran	Snapp	2014	Unknown

Note: The information above is incomplete and subject to errors given that many ridesharing companies are not public and their valuations are assessed only periodically.

APPENDIX

This appendix provides some information on 5G, Given the relatively small transfers of information between the passenger, driver, and ridesharing company, one might conclude that 5G would have limited impact on the ridesharing industry. That conclusion would be wrong. As discussed in *The Advance to 5G*, one of the two drivers behind 5G is the opportunity to advance the internet of things (IoT). Through the IoT and machine- to-machine connectivity, ridesharing is likely to be completely transformed.

A strong case can be made that with the deployment of 5G technology autonomous and driverless cars will be a norm. Moreover, what an individual vehicle and passenger connect to when travelling will change dramatically. 5G will enable the required high speed of interconnectivity and thereby enhance vehicle-to-infrastructure (V2I) communications. This will also connect vehicles with infrastructure like traffic lights, bus stops, and even the road itself thus improving traffic flow, lessen external danger factors, increase vehicle reaction time, and make an efficient public transportation (CB Insights, 2019). Fast, real-time vehicle-to-vehicle (V2V) communications that will help improve road safety.

In the 5G era, the automobile market will be evolving into a convergence with service market given the rise of smart vehicles. This will support a customized transportation services which connects drivers, automobile, road, and ICT infrastructures. The demand for safe and convenient driving will facilitate the convergence of vehicle and IT which will drive a huge paradigm shift in automobile industry from a manufacturer-oriented vehicle market to drive-oriented transportation service market (5G Forum, 2016)

5G will enable key innovations such as fleet telematics systems (FTS) to manage vehicle data in real time and give autonomous vehicles on the road to react on obstructions and other vehicles. When things go wrong, 5G will enable real-time data and reports to be sent to insurance companies and service vehicles (CB Insights, 2019).

Companies that can integrate technologies using 5G and the IoT will become the leaders in mobility and service. Passenger experiences will improve and ridesharing volumes will grow. According to Allied Business Intelligence, the revenues of ridesharing companies will grow from USD 30 billion in 2017 to USD 250 billion in 2022 (Aeris, 2020). As the range of services increases to include air travel and last-mile transportation, the industry will grow even more.

Integration, joint ventures, contracting, licensing and other means of coordination will be required. Whether barriers to entry in to ridesharing will increase is an important question. A related issue is whether successful ridesharing companies will be able to strengthen their relationships with passengers and reduce switching. No doubt that ridesharing companies will try to differentiate their experiences and encourage passengers to make asset-specific investments, e.g., learning about how to adjust the environment, use digital services while riding, and have the vehicle automatically adjust to each individual's preference.

With the full implementation of 5G, consumers will be able to order a car though their phone and the FTS will direct the nearest car to their location. The system will navigate and will bring the passengers to their destination quickly and efficiently, with or without a driver (Aeris, 2020).

Continued innovation will reinforce the trend of non-ownership of personal vehicles. As the MaaS will bring multiple service-based mobility options onto one platform, users will have options for choosing transportation services, public or private with one platform and interface (FinancialExpress, 2019).

As indicated above, consumers may become more or less loyal to particular companies based on the quality of service, cost, and investments in learning how to optimize their experiences with more (or less) user-friendly interior designs (McKinsey , 2017).

Even after autonomous vehicles are allowed on the streets, some will still have human drivers. Drivers will benefit from more safe and convenient driving (Goodwin, 2018). However, the role for human drivers is likely to diminish over time.

On the onset of 5G technology, OEMs will manufacture vehicles with new digital experience, delivering increased driver safety, enhanced vehicle management and extra convenience for drivers (Openbay, n.d.). Traditional vehicle manufacturing will become a business with increasingly narrower profit margins, therefore OEMs will need to either vertically integrate or rethink how they position themselves in an ecosystem of former competitors, tech companies and start-ups. [43] As with any disruptive technology and a new ecosystem, car manufacturers will experience divergent fates, including exit.

With the development of fleets of autonomous vehicles, ridesharing companies will benefit from economies of scale and network effects.

Differences in local, regional, and country infrastructures may a big factor in the successes of individual firms and eventual market structure. Successful companies may also be able to learn how to adjust to differences across localities and become more global. On the other hand, governments are likely to play substantial roles in determining how ridesharing companies connect with their transportation infrastructure. It is hard to believe that the same sets of companies that succeed in one locality will be favored by governments in others.

In general, when the required investments increase, industries become more concentrated. Ridesharing companies are now "asset light" but are likely to become "asset heavy."[44] Their investments may include huge technology budgets, fleets of vehicles, and specific investments in connectivity across geographies. It is highly likely that except for vehicles and micromobility devices, these companies will also own transportation and technology infrastructure.

Customers' mobility data will help ridesharing companies optimize decisions on where to station fleets to best serve the demand. Asset utilization efficiency will increase.

Of course, ridesharing companies might be able to collect a lot of information about transportation conditions and individual passengers. Will this information be valuable? The usual caveat applies, i.e., do not forget competition.

[43] https://www.mckinsey.com/industries/automotive-and-assembly/our-insights/reimagining-the-auto-industrys- future-its-now-or-never

[44] Like micromobility companies, which in most cases own and service their fleets.

Readings:

5G Forum. (2016). *5G Service Roadmap.* Republic of Korea.

Aeris. (2020). *Aeris.com*. Retrieved from Aeris: https://www.aeris.com/news/post/5g-enabled-autonomous-vehicles-will-drive-ride-sharing-market-growth/

CB Insights. (2019, March 19). *5G & The Future Of Connectivity: 20 Industries The Tech Could Transform*. Retrieved from CBInsights.com: https://app.cbinsights.com/research/5g-technology-disrupting-industries/

FinancialExpress. (2019). *FinancialExpress*. Retrieved from Financialexpress.com: https://www.financialexpress.com/industry/technology/how-5g-iot-ride-sharing-autonomous-vehicle-will-change-the-way-we-commute/1510084/]

Goodwin, A. (2018, October 26). *CNET.com*. Retrieved from CNET: https://www.cnet.com/roadshow/news/how-5g-connectivity-will-affect-cars-and-transportation/

McKinsey. (2017). *Cracks in the ridesharing market—and how to fill them.* McKinsey & Company.

Openbay. (n.d.). *What does 5G rollout mean for drivers*. Retrieved from Openbay.com: https://www.openbay.com/blog/what-does-5g-rollout-mean-for-drivers/

RideSharing Market. (2018). Retrieved from Marketsandmarkets.com: https://www.marketsandmarkets.com/Market-Reports/mobility-on-demand-market-198699113.html#:~:text=The%20ride%20sharing%20market%20is,and%20fall%20in%20car%20ownership.

Suggestions for reading:

Jonathan V. Hall, John J. Horton, and Daniel T. Knoepfle, Ridesharing Markets Re-Equilibrate, NBER Working Paper No. 30883, February 2023.

https://www.economist.com/special-report/2023/04/14/an-electric-shock